CLAIMS

What is claimed is:

1. A magnetic element comprising:

a free layer being ferromagnetic and having a free layer magnetization;

a spacer layer, the spacer layer being nonmagnetic; and

a pinned layer, the spacer layer residing between the pinned layer and the free layer, the pinned layer including a first ferromagnetic layer having a first magnetization, a second ferromagnetic layer having a second magnetization, a nonmagnetic spacer layer, and a spin depolarization layer, the nonmagnetic spacer layer being conductive and residing between the first ferromagnetic layer and the second ferromagnetic layer such that the first magnetization and the second magnetization are antiparallel, the spin depolarization layer being configured to depolarize at least a portion of a plurality of electrons passing through the spin depolarization layer;

wherein the magnetic element is configured to allow the free layer magnetization to change direction due to spin transfer when a write current is passed through the magnetic element.

2. The magnetic element of claim 1 wherein the spin depolarization layer further includes PtMn, Mn, Pt, IrMn, CuMn, and/or CuPt.

3. The magnetic element of claim 2 wherein the CuMn includes two to eight atomic percent of Mn.

4. The magnetic element of claim 2 wherein the CuPt includes two to eight atomic percent of Pt.

5. The magnetic element of claim 1 wherein the spin depolarization layer has a thickness of between two and eight Angstroms.

6. The magnetic element of claim 1 wherein the spin depolarization layer resides between the nonmagnetic spacer layer and the second ferromagnetic layer, the first ferromagnetic layer being closer to the free layer than the second ferromagnetic layer.

7. The magnetic element of claim 1 wherein the spin depolarization layer resides between the nonmagnetic spacer layer and the first ferromagnetic layer, the first ferromagnetic layer being closer to the free layer than the second ferromagnetic layer.

8. The magnetic element of claim 1 wherein the spin depolarization layer resides within the first ferromagnetic layer, the first ferromagnetic layer being closer to the free layer than the second ferromagnetic layer.

9. The magnetic element of claim 1 wherein the spacer layer is conductive and wherein the magnetic element further includes:

a barrier layer, the barrier layer being an insulator and having a thickness that allows tunneling through the barrier layer;

a second pinned layer, the barrier layer being between the free layer and the second pinned layer, the second pinned layer being ferromagnetic.

10. The magnetic element of claim 9 wherein the first ferromagnetic layer is closer to the free layer than the second ferromagnetic layer, wherein the second pinned layer has a third magnetization antiparallel to the first magnetization.

11. The magnetic element of claim 9 wherein the second pinned layer includes a third ferromagnetic layer having a third magnetization, a fourth ferromagnetic layer having a fourth magnetization, and a second nonmagnetic spacer layer, the second nonmagnetic spacer layer being conductive and configured such that the third magnetization is antiparallel to the fourth magnetization and wherein the free layer further includes a fifth ferromagnetic layer having a fifth magnetization, a third nonmagnetic spacer layer, and a sixth ferromagnetic layer having a sixth magnetization, the third nonmagnetic spacer layer residing between the fifth ferromagnetic layer and the sixth ferromagnetic layer, the fifth magnetization being antiparallel to the sixth magnetization.

12. The magnetic element of claim 11 wherein the third magnetization is parallel to the first magnetization, wherein the first ferromagnetic layer is closer to the free layer than the second ferromagnetic layer, and wherein the third ferromagnetic layer is closer to the free layer than the fourth ferromagnetic layer.

13. The magnetic element of claim 11 wherein the second pinned layer further includes a second spin depolarization layer, the second spin depolarization layer being configured to depolarize at least a second portion of the plurality of electrons passing through the second spin depolarization layer.

14. The magnetic element of claim 1 wherein the free layer further includes a second spin depolarization layer.

15. The magnetic element of claim 1 wherein the free layer is a synthetic free layer including a second spin depolarization layer.

16. The magnetic element of claim 1 further comprising:

a second pinned layer, the second pinned layer being ferromagnetic;

a second spacer layer;

a second free layer, the second spacer layer being between the second free layer and the second pinned layer, the second free layer having a second free layer magnetization, the second free layer magnetization being magnetostatically coupled with the free layer magnetization.

17. The magnetic element of claim 16 further comprising:

a separation layer configured such that the second free layer magnetization is magnetostatically coupled with the free layer magnetization.

18. The magnetic element of claim 16 wherein the spacer layer is conductive and the second spacer layer is an insulating barrier layer.

19. The magnetic element of claim 16 wherein the second pinned layer includes a third ferromagnetic layer having a third magnetization, a fourth ferromagnetic layer having a fourth magnetization, and a second nonmagnetic spacer layer between the third ferromagnetic layer and the fourth ferromagnetic layer, the second nonmagnetic spacer layer being conductive and configured such that the third magnetization is antiparallel to the fourth magnetization.

20. The magnetic element of claim 16 wherein the second pinned layer further includes a second spin depolarization layer, the second spin depolarization layer being configured to depolarize at least a second portion of the plurality of electrons passing through it the second spin depolarization layer.

21. A magnetic element comprising:

a free layer being ferromagnetic and having a free layer magnetization;

a spacer layer, the spacer layer being nonmagnetic; and

a pinned layer, the spacer layer residing between the pinned layer and the free layer, the pinned layer including a first ferromagnetic layer having a first magnetization, a second ferromagnetic layer having a second magnetization, and a nonmagnetic spacer layer, the nonmagnetic spacer layer being conductive and residing between the first ferromagnetic layer and the second ferromagnetic layer such that the first magnetization and the second

magnetization are antiparallel, the first ferromagnetic layer ferromagnetic layer being doped with at least a first material such that a first spin diffusion length of the first ferromagnetic layer is reduced, the second ferromagnetic layer being doped with at least a second material such that a second spin diffusion length of the second ferromagnetic layer is reduced;

wherein the magnetic element is configured to allow the free layer magnetization to change direction due to spin transfer when a write current is passed through the magnetic element.

22. A method for providing a magnetic element comprising:

(a) providing a free layer being ferromagnetic and having a free layer magnetization;

(b) providing a spacer layer, the spacer layer being nonmagnetic; and

(c) providing a pinned layer, the spacer layer residing between the pinned layer and the free layer, the pinned layer including a first ferromagnetic layer having a first magnetization, a second ferromagnetic layer having a second magnetization, a nonmagnetic spacer layer, and a spin depolarization layer, the nonmagnetic spacer layer being conductive and residing between the first ferromagnetic layer and the second ferromagnetic layer such that the first magnetization and the second magnetization are antiparallel, the spin depolarization layer being configured to depolarize at least a portion of a plurality of electrons passing through the spin depolarization layer;

wherein the magnetic element is configured to allow the free layer magnetization to change direction due to spin transfer when a write current is passed through the magnetic element.

23. The method of claim 22 wherein the step of providing the pinned layer (c) further includes:

(c1) providing the spin depolarization layer including PtMn, Mn, Pt, IrMn, CuMn, and/or CuPt.

24. The method of claim 23 wherein the CuMn includes two to eight atomic percent of Mn.

25. The method of claim 23 wherein the CuPt includes two to eight atomic percent of Pt.

26. The method of claim 22 wherein the pinned layer providing step (c) further includes the step of:

(c1) providing the spin depolarization layer with a thickness of between two and eight Angstroms.

27. The method of claim 22 wherein the pinned layer providing step (c) further includes the step of:

(c1) providing the spin depolarization layer between the nonmagnetic spacer layer and the second ferromagnetic layer, the first ferromagnetic layer being closer to the free layer than the second ferromagnetic layer.

28. The method of claim 22 wherein the pinned layer providing step (c) further includes the step of:

(c1) providing spin depolarization layer between the nonmagnetic spacer layer and the first ferromagnetic layer, the first ferromagnetic layer being closer to the free layer than the second ferromagnetic layer.

29. The method of claim 22 wherein the pinned layer providing step (c) further includes the step of:

(c1) providing the spin depolarization layer within the first ferromagnetic layer, the first ferromagnetic layer being closer to the free layer than the second ferromagnetic layer.

30. The method of claim 22 wherein the spacer layer is conductive and wherein the method further includes:

(d) providing a barrier layer, the barrier layer being an insulator and having a thickness that allows tunneling through the barrier layer; and

(e) providing a second pinned layer, the barrier layer being between the free layer and the second pinned layer, the second pinned layer being ferromagnetic.

31. The method of claim 30 wherein the first ferromagnetic layer is closer to the free layer than the second ferromagnetic layer, wherein the second pinned layer has a third magnetization antiparallel to the first magnetization.

32. The method of claim 29 wherein the second pinned layer providing step (e) further includes:

(e1) providing a third ferromagnetic layer having a third magnetization;

(e2) providing a fourth ferromagnetic layer having a fourth magnetization; and

(e3) providing a second nonmagnetic spacer layer, the second nonmagnetic spacer layer being conductive and configured such that the third magnetization is antiparallel to the fourth magnetization; and wherein the free layer providing step (a) further includes

(a1) providing a fifth ferromagnetic layer having a fifth magnetization,

(a2) providing a third nonmagnetic spacer layer, and

(a3) providing a sixth ferromagnetic layer having a sixth magnetization, the third nonmagnetic spacer residing between the fifth ferromagnetic layer and the sixth ferromagnetic layer, the fifth magnetization being antiparallel to the sixth magnetization.

33. The method of claim 32 wherein the third magnetization is parallel to the first magnetization, wherein the first ferromagnetic layer is closer to the free layer than the second ferromagnetic layer, and wherein the third ferromagnetic layer is closer to the free layer than the fourth ferromagnetic layer.

34. The method of claim 33 wherein the second pinned layer further providing step (e) further includes the step of:

(e4) providing a second spin depolarization layer, the second spin depolarization layer being configured to depolarize at least a portion of a plurality of electrons passing through the second spin depolarization layer.

35. The method of claim 22 further comprising:

(d) providing a second pinned layer, the second pinned layer being ferromagnetic;

(e) providing a second spacer layer;

(f) providing a second free layer, the second spacer layer being between the second free layer and the second pinned layer, the second free layer having a second free layer magnetization, the second free layer magnetization being magnetostatically coupled with the free layer magnetization.

36. The method of claim 35 further comprising:

(g) providing a separation layer configured such that the second free layer magnetization is magnetostatically coupled with the free layer magnetization.

37. The method of claim 34 wherein the spacer layer is conductive and the second spacer layer is an insulating barrier layer.

38. The method of claim 35 wherein the second pinned layer providing step (d) further includes

(d1) providing a third ferromagnetic layer having a third magnetization;

(d2) providing a fourth ferromagnetic layer having a fourth magnetization; and

(d3) providing a second nonmagnetic spacer layer, the second nonmagnetic spacer layer being conductive and configured such that the third magnetization is antiparallel to the fourth magnetization.

39. The method of claim 38 wherein the second pinned layer providing step (d) further includes

(d4) providing a second spin depolarization layer, the second spin depolarization layer being configured to depolarize at least a portion of a plurality of electrons passing through the second spin depolarization layer.

40. The method of claim 22 wherein the free layer further includes a second spin depolarization layer.

41. The method of claim 22 wherein the free layer is a synthetic free layer including a second spin depolarization layer.

42. A method for providing a magnetic element comprising:

(a) providing a free layer being ferromagnetic and having a free layer magnetization;

(b) providing a spacer layer, the spacer layer being nonmagnetic; and

(c) providing a pinned layer, the spacer layer residing between the pinned layer and the free layer, the pinned layer including a first ferromagnetic layer having a first magnetization, a second ferromagnetic layer having a second magnetization, and a nonmagnetic spacer layer, the nonmagnetic spacer layer being conductive and residing between the first ferromagnetic layer and the second ferromagnetic layer such that the first magnetization and the second magnetization are antiparallel, the first ferromagnetic layer ferromagnetic layer being doped with at least a first material such a first spin diffusion

length of the first ferromagnetic layer is reduced, the second ferromagnetic layer being doped with at least a second material such that a second spin diffusion length of the second ferromagnetic layer is reduced;

wherein the magnetic element is configured to allow the free layer magnetization to change direction due to spin transfer when a write current is passed through the magnetic element.